GRASS GROWING SUPERSTRATE & METHODS OF USE

The present invention relates to a grassed supporting surfaces and, more particularly, to a superstrate particularly, but not exclusively, adapted as a medium for the growth of organic materials such as plants, grass and the like, suited for application in various forms to a variety of existing ground structures and uses.

BACKGROUND

Grassed surfaces are preferred, and indeed in many situations, are essential in a wide range of human activities and environments. Numerous sports are of course played on grass and the widely different characteristics of many sports make different demands on the surfaces on which they are played. Thus for example, there is an enormous difference between the characteristics required of grass surfaces for the games of tennis and the racing of horses.

In many sporting applications there are particular areas of the surface which are subject to very heavy wear and tear and it can be a major problem to maintain such areas in good conditions so as to present a satisfactory whole. Examples may be found in the surrounding edges of golf course bunkers, teeing off areas and greens. Particularly around some bunkers and teeing off areas, the ground may slope quite steeply, making it susceptible to erosion and damage. Many other examples of areas of heavy

wear in sport contexts can be given, such as occur around football field goal mouths and side lines, the area around cricket pitches and the service lines of tennis courts to mention a few. Yet other examples may be found in grass adjoining swimming pools and other areas subject to frequent pedestrian or even vehicular access.

A major differentiating characteristic between the requirements of various sports is that of resilience of the superstrate of the playing surface. Thus while the requirements of a grass tennis court approach that of virtually zero resilience, racecourses and football fields lie at the opposite end of a spectrum of resilience. In the case of both the latter applications, high resilience is required to prevent physical damage to horses and players but even here the optimum resilience will be different.

Such control of optimum resilience in soil-based grass surfaces is very difficult to establish and maintain.

Another problem associate with soil-based grass surfaces is that they can take a significant amount of time to return to usability or even to recover from structural damage after heavy rainfall. As increasing demands for availability are placed on sporting venues, the issues of recoverability from both wear and rainfall become critical to the economic viability of venues, as well as to the maintenance of the demanding schedules of sporting club fixtures.

At major sports ovals where, as well as the attending audience, television may bring the game to millions of viewers, the playing surface itself has become a valuable area for the display of advertising indicia. One method for the display of such indicia in common use is to apply paint to the grass surface but these areas become difficult to maintain and, when the advertising is no longer desired, difficult to clean and restore.

With the increasing densification of urban living, outdoor areas such as rooftops, terraces and other constructed areas are increasingly adapted as gardens with grass as a preferred surface. Soil-based grass is difficult to maintain in such areas, frequently suffering waterlogging problems leading to root rot and deterioration of appearance.

A superstrate adapted to the growing of grassed surfaces as disclosed by PCt/AU00/01295 by the present inventor, provided a basis for a product adapted to address some of the above problems. Further development of that superstrate, control of its mechanical properties and applications are addressed in the present specification.

BRIEF DESCRIPTION OF INVENTION

Accordingly, in one broad form of the invention there is provided a turf comprising a combination of a superstrate and grass, wherein said superstrate is adapted to the soil-less growing of said grass; and wherein

said combination of said superstrate and said grass is further adapted to selective formulation to suit the specific requirements of selected ones from a plurality of grassed surface applications.

Preferably said superstrate is formed from a mixture, said mixture including the ingredients of elastomeric granules, suitable binding emulsion, mineral aggregate, filler and slow release plant nutrient particles mixed in sufficient proportions so that, when laid and cured, said mixture produces a water permeable, resilient superstrate having air pockets through which a root system of said turf forming grass can penetrate.

Preferably said elastomeric granules include granules of recycled vehicle tyre rubber.

Preferably said elastomeric granules include granules of new rubber.

Preferably said elastomeric granules include a mixture of granules of recycled rubber and granules of new rubber.

Preferably said binding emulsion includes bituminous emulsion.

Preferably said bituminous emulsion is polymer modified.

Preferably said mineral aggregate is one or more selected from a set of aggregates in particulate form, said set including basalt, sand and crusher dust.

Preferably said filler is one or more selected from a set of fillers in particulate form, said set including cement dust and fly-ash.

Preferably said ingredients further include a chemical retardant adapted to slow processes of flocculation and coalescence, said processes acting so as to coat said particulate forms of said ingredients with said bituminous emulsion.

Preferably said resilience of said superstrate is a function of the proportion of said elastomeric granules in said superstrate; higher proportions conferring correspondingly greater resilience to said superstrate.

Preferably said resilience of said superstrate is a function of the average mesh size of said elastomeric granules.

Preferably said water permeability of said superstrate is a function of said proportion of said elastomeric granules and said average mesh size of said elastomeric granules.

Preferably said resilience and said water permeability are functions of the thickness of said superstrate.

Preferably said grassed surface applications include the playing surfaces of a range of sporting activities.

Preferably said playing surfaces include a grassed surface adapted to the playing of tennis.

Preferably said playing surfaces include grassed surfaces adapted to any of a range of sports characterized by the term football.

Preferably said playing surfaces include a range of grassed surfaces adapted to the game of golf.

Preferably said playing surfaces include grassed surfaces adapted to the running of horse races.

Preferably said turf is adapted for application to high wear areas around golf course bunkers.

Preferably said turf is adapted for the minimization of erosion in water courses.

Preferably said turf is adapted to the stabilisation of steep embankments.

Preferably said grassed surface applications include the covering of non porous surfaces.

Preferably the resilience of said superstrate is adapted to specified performance characteristics of any one of a plurality of sporting activities.

Accordingly, in another broad form of the invention there is provided a method for the forming of a layer of a superstrate adapted to the soil less growing of grass so as to form a turf, said method including the steps of:

(a) combining in a suitable mechanical mixing machine ingredients including granulated elastomer, mineral aggregate, filler and slow release plant

nutrient particles so as to produce a homogenous mixture;

(b) adding to said mechanical mixing device a suitable binding emulsion for chemical interaction with said homogenous mixture so as to form a homogenous slurry.

Preferably said granulated elastomer includes granules of new rubber.

Preferably said granulated elastomer includes granules of recycled vehicle tyre rubber.

Preferably said granulated elastomer includes a mixture of granules of recycled rubber and granules of new rubber.

Preferably said binding emulsion includes a polymer modified bituminous emulsion.

Preferably said mineral aggregate includes one or more selected from a set of aggregates in particulate form, said set including basalt, sand and crusher dust.

Preferably said filler includes one or more selected from a set of fillers in particulate form, said set including cement dust and fly-ash.

Preferably said ingredients further include a chemical retardant adapted to slow processes of flocculation and coalescence, said processes acting so as to coat said particulate forms of said ingredients with said bituminous emulsion.

Preferably said slurry is extruded from said mixing machine in a continuous strip of superstrate onto a surface of application so as to form, when cured, a homogenous water permeable and resilient layer.

Preferably said slurry is extruded from said mixing mchine in a continuous strip of superstrate onto a surface for curing into a homogenous water permeable and resilient layer, said layer adapted in thickness so as to allow lengths of said layer to be rolled into rolls for transport to a surface of application.

Preferably wherein said slurry is extruded from said mixing machine sequentially into trays for curing to form trays of superstrate, said trays of superstrate adapted for transport to a surface of application.

Accordingly, in yet another broad form of the invention there is provided a method for the growing of grass on said superstrate as defined above so as to form a turf, wherein said superstrate is seeded with a selected variety of grass seed to suit a predetermined grassed surface application.

Accordingly, in yet another broad form of the invention there is provided a method for the growing of grass on said superstrate so as to form a turf, wherein said superstrate is scarified prior to the seeding of said superstrate with a selected variety of grass seed to suit a predetermined grassed surface application.

Accordingly, in yet another broad form of the invention there is provided a method for the growing of grass on said superstrate so as to form a turf, wherein sprigs of a selected species of grass are inserted into the upper surface of uncured superstrate so as to form a grassed surface when the roots of said grass have pentrated said superstrate.

Accordingly, in yet another broad form of the invention there is provided a method for the growing of grass on said superstrate so as to form a turf, wherein a pre-grown mat of washed substantially soil-less grass is laid onto the upper surface of cured superstrate so as to form a grassed surface when the roots of said grass mat have penetrated said superstrate.

Accordingly, in yet another broad form of the invention there is provided a method for the growing of grass on said superstrate so as to form a turf, wherein a pre-grown mat of washed substantially soil-less grass is pressed onto the upper surface of uncured superstrate so as to form a grassed surface when the roots of said grass mat have penetrated said superstrate.

Accordingly, in yet another broad form of the invention there is provided a method for the application of the turf defined above to a surface of application, said method including the steps of:

(a) extruding strips of said slurry from said mixing machine directly onto said surface of application so as to form after curing a homogeneous, resilient water permeable superstrate,

(b) promoting the growth of grass on said superstrate by any one of the methods of:

(i) seeding said superstrate with a selected variety of grass seeds,

(ii) inserting sprigs of a selected variety of grass into the partly cured surface of said superstrate,

(iii) applying pre-grown, washed, substatially soil-less strips of grass mat to said superstrate surface.

Accordingly, in yet another broad form of the invention there is provided a method for the application of the turf to a surface of application, said method including the steps of:

(a) extruding strips of said slurry from said mixing machine onto a surface for curing so as to form a superstrate,

(b) promoting the growing of a selected variety of grass on said superstrate to form strips of turf,

(c) rolling said strips into rolls suitable for transportation to said surface of application,

(d) laying said strips onto said surface of application.

Accordingly, in yet another broad form of the invention there is provided a method for the application of the turf to a surface of application, said method including the steps of:

(a) extruding segments of said slurry into said trays to form trays of superstrate,

(b) promoting the growing of a selected variety of grass on said superstrate to form trays of turf,

(c) transporting said trays to said surface of application when required,

(d) laying said trays on said surface to form a contiguous array of turf segments.

Accordingly, in yet another broad form of the invention there is provided a method for the surfacing of a sport playing area, said method including the steps of:

(a) preparing a subsurface to a required specification of levelness and to a required specification of water drainage and removal capacity;

(b) identifying areas of said surface suitable for periodic replacement of said surface due to expected high wear;

(c) selecting methods of application of said turf from any one of the methods of claims 41 to 43;

(d) applying said turf to said surface.

Accordingly, in yet another broad form of the invention there is provided a method of displaying advertising indicia on a surface for the playing of sport, said method including the steps of:

(a) preparing predetermined segments of turf with selected said indicia;

(b) removing selected portions equivalent in shape and extent to said segments from said surface;

(c) inserting said segments into said surface.

Accordingly, in yet another broad form of the invention there is provided a method for the exchanging of advertising indicia for display on a grassed surface, said method including the steps of:

(a) preparing and maintaining a range of predetermined segments of turf with selected said indicia;

(b) extracting an existing segment of turf displaying existing advertising indicia;

(c) inserting selected one of said range of segments into said surface.

Accordingly, in yet another broad form of the invention there is provided a method for the maintenance of high wear areas of a sport playing surface, said method including the steps of:

(a) surfacing said high wear areas with a selected one of prepared sections of turf comprising a

resilient water permeable superstrate and grass; said sections including strips of said turf and segments of said turf formed in trays;

(b) removing worn sections of said turf when required;

(c) replacing said worn sections with said prepared sections of turf.

Accordingly, in yet another broad form of the invention there is provided a method of resurfacing an area of the turf as defined above, said method including the steps of:

(a) mechanically removing a sufficient depth of said superstrate and said grass to allow the laying of a fresh layer of superstrate;

(b) extruding said slurry onto remaining superstrate sufficient to restore said superstrate to preexisting thickness when said slurry has cured;

(c) promoting the growth of fresh grass on said superstrate.

Accordingly, in yet another broad form of the invention there is provided a method for the recycling of water applied to the grassed surface of the above method , said method including the steps of:

(a) preparing a subsurface with an interconnected array of water collecting elements said elements adapted to the conveying of water to at least one collection point;

(b) providing a storage device for the collection of said water from said at least one collection point;

(c) providing pumping means for the raising of said water at a pressure sufficient to allow for the distribution of said water to said turf.

Accordingly, in yet another broad form of the invention there is provided a method of deriving revenue from a grassed surface; said method including the steps of:

(a) applying the turf to a surface of application at a cost based on:

(i) method of application;

(ii) specifications of said superstrate and said grass;

(iii) area to be covered;

(iv) maintenance provisions.

BRIEF DESCRIPTION OF DRAWINGS

Embodiments of the present invention will now be described with reference to the accompanying drawings wherein:

Fig. 1 is a cross section view of a turf comprising a superstrate supporting grass in accordance with a preferred embodiment of the present invention applied to an existing ground structure;

Fig. 2A is a side view of a preferred method of superstrate production according to the invention;

Fig. 2B is a side view of a further preferred method of superstrate production;

Fig. 2C is a perspective view of a tray adapted to support a segment of the turf of Fig. 1

Fig. 3 is a test result of performance characteristics of a particular formulation of the turf of Fig. 1.

Fig. 4 is a test result of performance characteristics of a further formulation of the turf of Fig. 1.

Fig. 5 is as test result of performance characteristics of yet a further formulation of the turf of Fig. 1.

Fig. 6 is a test result of a comparison of performance characteristics of a formulation of the turf of Fig. 1 and conventional soil based turf.

Fig. 7 is a test result of performance characteristics of the turf of Fig. 1 in a first dry/moist condition and in a second wet/saturated condition.

Fig. 8 is a perspective view of a playing field formed from turf segments according to a preferred embodiment of the invention.

Fig. 9 is a side view of a turf segment replacement method according to the invention.

Fig. 10 is a perspective view of a playing field formed from turf in the form of a plurality of embodiments of the present invention.

Fig. 11 is a schematic of a water recycling method applied to a playing field formed from turf according to the invention.

DETAILED DESCRIPTION OF PREFERRED EMBODIMENTS

With reference, initially, to Fig. 1 there is illustrated in cross section view a superstrate 11 adapted to the growing of a wide variety of grasses so as to form a turf 10 applied to and over a surface 12 of an existing ground structure 13 thereby to present a grassed surface 14 lying in a plane substantially parallel to the plane of surface 12 and elevated with respect thereto by the thickness "T" of the superstrate 11. For the purposes of this specification the word "turf" refers to the combination of a surface of natural grass and a superstrate formulated according to processes disclosed within this specification.

The superstrate 11 is of a thickness and of a composition which permits the permeation of root structures 15 therethrough and so support a surface growth of grass 14 as shown in the inset in Fig. 1. As also shown in the inset in Fig. 1 the superstrate 11 includes cavities 16 distributed therethrough which can take the form of air pockets and fissures into which the root structures 15 can penetrate. Superstrate 11 may be formulated to act as the carrier for a range of grasses, including specialised sport grass species, suited to particular applications.

Moreover, superstrate 11 may be produced in a number of different formats and by various processes to exhibit a variety of predetermined engineering characteristics adapted to suit a wide range of applications and situations as described below.

Broadly, superstrate 11 in accordance with a first preferred embodiment of the present invention, comprises a mixture of elastomeric material in granular form together with a polymer based emulsifier and a filler. A preferred formulation of ingredients is described in more detail below.

Methods of Superstrate Production

Superstrate may be produced in a variety of different forms as shown in Fig. 2. In all forms the ingredients are mechanically combined into a homogenous mixture to form an initial slurry adapted for extrusion into a layer of a required thickness and mechanical properties after curing.

In a first preferred embodiment of the production process as shown in Fig. 2A, the slurry mixture is extruded in continuous strips 20. This process may be performed on site for in situ application directly to the surface to be covered, or off site for later transport and laying. The width and length of strips are functions of the intended application; the maximum width being determined by the mixing equipment 21 used. Where only a thin superstrate is required such as in applications where the turf will be

laid onto a porous surface allowing root penetration, strips may be rolled up for transport and delivery. The thickness of such rolled strips may lie in the range of 20 to 50 mm. For thicker superstrates the strips may be adapted for flat transportation and handling. Typically such strip material may have a thickness range of 50 to 100mm.

In situ pours may be made on slopes of up to approximately 33 degrees. For steeper slopes a stabilizing grid may be incorporated in the superstrate layer.

Extruded strips produced off- site may optionally be cut into rectangular square or rectangular tiles for convenience of transport and handling as required.

In a second preferred embodiment of the process shown in Fig. 2B, the superstrate 11 is extruded onto tray structures 22 so as to form turf modules 23. The trays structures 22 as shown in Fig. 2C may be formed so as to have at least one lifting point 24 adapted for the transport and laying of the modules by mechanical lifting means. Typical preferred thickness of modules may lie in the range of 80 to 120mm.

In both the first and second embodiments of the process described above, strips, tiles or modules may be provided with the grass of choice either at the point of manufacture or at the point of laying, depending on the preferred method of applying the grass, that is whether to

superstrate in a cured or partially cured condition as described below.

In a third preferred embodiment of the method of superstrate production, ingredients are introduced and mixed in a mobile road surfacing machine such as used for the deposition of a continuos bituminous surface layer. In this form the superstrate is laid directly onto the surface of application. Again grass may be added in any one of the methods described below.

Examples of Superstrate Formulation

Example 1

A superstrate according to a pereferred embodiment of the present invention may be produced by firstly dry, cold mixing in a PAVESEAL"™ mixing machine equipped with a calibrated continuous flow means (such as is used for road making) a combination of about 32.8% w/w recycled, reconstituted or new rubber with an average mesh size (according to accepted standards) of between about 7 and 16, about 32.8% w/w mineral aggregate (of stone size up to about 10 mm diameter) such as basalt, sand or crusher dust, about 4.0% w/w filler, such as cement dust and fly ash, about 2.6% w/w additive, such as chemical retardants that slow down the breaking" of emulsions, and about 0.8% w/w of water absorbing, slow release plant nutrient crystals, such as fertilizers coated with sulphur or a polymer that breaks down when subjected to specific conditions of temperature,

moisture and/or time.

In the present Example, the source of plant nutrient used was that known by the trade mark TERRACOTTEM, which is an ideal plant nutrient source because it is relatively high in potassium, has organic water absorbent polymers which increase the capacity of the growth superstrate to retain and provide water and nutrient, has a starter component of soluble and slow release mineral and organic nutrients which play an important role during the initial growth phase of the plants, such as turf forming grasses, and are also active for many months thereafter, has a trace amount of growth stimulating agent which encourages extensive root development in the initial growth phase, and has a carrier material which allows for homogeneous distribution of the crystals.

After about 7 to 10 minutes of dry, cold mixing, a thorough blend is formed.

About 27.0% w/w of a generic brand of polymer modified bituminous emulsion in water is then added to the mixture until a flowable or workable consistency of the mixture is formed. The polymer may be ethyl vinyl acetate or SBS. The emulsion may contain up to about 17.5% w/w of residual binder, such as latex. Water is also a large component of the emulsion. Typical emulsions are those produced by SHELL™, MOBIL™, PIONEER™, and other corporations involved in marketing of polymer modified bituminous emulsions. The

emulsion is run through a MAGFLOW™ meter and is constantly monitored by the operator. The flow is calibrated to ensure that the emulsion sufficiently coats the rubber, aggregate and filler. Some adjustment in the amount of additive and water may be required to achieve the required workable consistency and to avoid premature "breaking" of the emulsion.

Although various mixing techniques may be employed, it is important to note that constant agitation is not necessary. A minimum of mechanical agitation is required to quickly coat the rubber, aggregate and filler with emulsion. Excessive mechanical agitation may prematurely "break" the emulsion or abrade the coating of emulsion from the rubber and aggregate. If the emulsion "breaks" prematurely, the resultant product fails to bond together adequately. For this reason, small concrete mixers and the like are not suitable for use as their lift blades rotate too quickly, and produce high shearing forces. Ideally, the mixing machine useful in the present invention should,

(1) operate its blades or augers at less than 1 0 rpm,

(2) have blades or augers which are as small as possible,

(3) have a mixture holding drum which is significantly greater in height than it is in diameter, and

(4) operate in as nearly a horizontal position as possible to avoid lifting, shearing and splashing the mixture. As well as premature "breaking" of the emulsion, excessive mechanical agitation can lead to frothing of the mixture and energy waste.

The mixing machine is operated at an ambient temperature of about 25° C, although mixing may be carried out at higher and lower temperatures if suitable adjustments are made to other mixing conditions and/or component concentrations.

When a workable consistency of the mixture is formed, it is poured or extruded out of the mixing machine at a flow rate of about 1 .5 kg per second, being forced by the augers through a screed box at the rear of the mixing machine which is at a height and over a location of use suited for pouring the still molten mixture.

The extrusion may be of any desired thickness depending on the application and is a function of the rate of extrusion and the movement of the mixing machine.

The extrusion rate may be adjusted depending on the ambient temperature and other circumstances which might affect the level of workable consistency of the mixture.

As the mixture leaves the mixing machine in the form of a "slurry", it has a characteristic brown colour attributable to the polymer modified bituminous emulsion, and as the mixture "breaks" after being laid as a

superstrate in its location of use, water is released by percolating through the superstrate and evaporating into the atmosphere. The "breaking" of emulsions is a commonly used reference in the art to a process known industrially as "flocculation and coalescence" of bitumen based emulsions, a process which is controlled by temperature, mechanical agitation, and the presence of any chemical retardants of the process. It is postulated that the "breaking" process involves a chemical reaction that coats irreversibly the inert particulate components of the mixture, namely the rubber, aggregate and filler used in the present Example, with the polymer modified bituminous emulsion, thereby bonding together the resultant superstrate. The "breaking" process leads to curing of the mixture, causing its colour to change from brown to black and its gradual loss of stickiness.

Curing is complete in about 30 to 40 minutes depending on the ambient temperature, and the superstrate is then, optionally, rolled into a mat of desired thickness and smoothness with the use of hydraulic vibrating and rolling machinery, which expels excess water and assists in the further bonding together of the resultant superstrate but does not cause compounding of the superstrate that would lead to loss of its desired properties.

Should the superstrate be required to have a particular resilience, adjustment of the concentration of

rubber in the mixture can be made, with the higher the concentration of rubber, the softer the surface.

The source of plant nutrient, which is in crystal form in the present Example, is stabily and accessibly trapped in the superstrate. The slow release of mineral and organic nutrients from the trapped nutrient source, coupled with the presence of air pockets critical for water permeation or percolation and drainage stimulates the development of root systems through the superstrate and the accompanying growth of the grass.

Example 2

A slightly slower growing turf than that grown on the superstrate of Example 1 may be produced on a better draining, more shock absorbing superstrate suitable for many sports by laying a loose overcushion of rubber shavings having a width in any direction of between about 20 mm and 80 mm so that the overcushion is to a depth of about 50 mm to 100 mm over the superstrate of Example 1. Randomly mixed in with, or sprinkled over, the overcushion is a quantity of the plant nutrient crystals used in the superstrate of Example 1. The thickness of the overcushion of rubber shavings and plant nutrient crystals is no more than about 200 mm. Growth of specialized sports turf grass is then induced by means described below. The grass takes root in the superstrate by developing root systems through both the overcushion and the superstrate of Example 1

acting as a base for the overcushion, and the surface can be used after about 30 days under normal weather conditions, but after about 14 days if the weather and other conditions are optimal.

The base and the overcushion, both being coloured black, readily absorb sunlight which is converted into heat. Although some of the heat energy is radiated into the atmosphere, much of it is conducted through the superstrate and overcushion causing a warming of the superstrate that promotes root penetration and the development of branching root systems throughout the superstrate, leading of course to faster turf growth and repair should the turf become damaged.

A similar benefit in the growth and repair of turf grass arising from the superstrate warming effect is provided by the superstrate of Example 1.

When established, the turf grown on the superstrate of the invention is maintained in a similar manner to soil based turf, but with the advantage that water and nutrient may be more efficiently used in promoting growth.

A typical composition of the artificial superstrate produced in Example 2, over an area of 150m^2 at a depth of 100 mm, to be covered by the same area of turf, is a follows:

- Rubber 4 tonnes
- Aggregate 29.34 tonnes

- Filler 313 kgs
- Emulsion 2500 litres approx.
  (2.54 tonnes approx)
- Plant Nutrient Crystals 15 kgs
- Overcushion 1 tonne
- Polymer Residual * 8% w/w

*Polymer Residual is a reference to the proportion of polymer in the polymer modified bituminous emulsion.

Granulated Rubber modified Slurry

A key ingredient in the process of superstrate formation is the bituminous emulsion which comprises a fine dispersion bitumen in water. Bituminous emulsions are widely used in agricultural and stabilization works where they are sprayed directly onto soil or embankment to promote vegetation. As such, they are considered to be environmentally compatible, providing that the fresh emulsion is reacted with fine particulate matter in the slurry, causing it to break and effectively lock in the bitumen with the slurry matrix. The breaking process involves a chemical reaction with the aggregate fines, resulting in an irreversible coating of the aggregate. Consequently, there is no possibility of the bitumen being mobilized to enter the environment. The particulate matter in the composition of the superstrate of the present invention is comprised of inert mineral

aggregates, cement filler and granulated rubber, which are effectively locked into the slurry matrix and in themselves do not pose any environmental concern. Consequently, the superstrate, when placed and cured, forms a durable paving product with no adverse impact on the environment.

Methods Grass Formation

Grass of choice to suit a particular application may be induced to grow into the superstrate in a number of ways.

In a first preferred method, cured superstrate may be simply sprinkled with grass seed, watered and the grass allowed to germinate after which the root structure will gradually penetrate the superstrate.

In a second preferred method, the cured superstrate is scarified prior to the addition of seed. As in the first method, watering induces germination followed by penetration of the root structure into the superstrate.

In a third preferred method, a mat of previously grown grass, washed so as to be essentially soil free, is laid onto the cured superstrate and the root structure allowed to penetrate the superstrate.

In a fourth preferred method, washed, essentially soil free sprigs of previously grown grass may be inserted into partially cured superstrate.

In a fifth preferred method, a mat of previously grown

grass, washed so as to be essentially soil free, is laid onto still wet, partly cured superstrate and pressed into the surface so as to bond to the superstrate to be followed by the process of root penetration.

In yet a further preferred method adapted to the grassing of tray modules, trays are fitted with a supporting grid at some preferred distance above the base of the tray. A mat of washed grass is placed in the tray on the grid and roots of the grass are then teased down towards the base of the tray and the slurry mix is poured or pumped into the tray below the level of the grid. This consolidates the roots and in fact uses the roots as part of the bonding system which adds strength and durability to the superstrate.

Examples of Nutrient Application

EXAMPLE 1

A number of different kinds of water absorbing, slow release plant nutrient crystals (also known in the art as slow release fertilizers) were used in turf growing trials with the superstrate of the present invention. When TERRACOTTEM™ slow release fertiliser was used at a rate ranging from 80 g/m^2 to 135 g/m^2, successful growth characteristics were achieved over a period of 12 months, and it is expected that similar characteristics will persist for a further 4 years.

Successful growth characteristics are defined as:

(a) the promotion of health plant and root growth,

(b) an increase in the size of the grass under controlled conditions, and

(c) an increase in the speed of growth.

These are direct comparisons drawn against a standard, soil based, equivalent superstrate.

EXAMPLE 2

Several common brand turf fertilizers for use in the superstrate of the present invention were trialed. Successful growth characteristics resulted with superstrates that incorporated either sulphur coated or polymer coated slow release fertilisers. Common brand turf fertilisers trialed include Osmocote™, Scotts Turf Supreme™ and Best Turf Gold™. The most successful growth characteristics came from using the Best Turf Gold™ fertilizer having a sulphur coated N:P:K:S formulation of 22:5:8:9.

EXAMPLE 3

Several organic and non organic liquid fertilizers were tested with turf growing on the artificial surface of the present invention. Most proved to be very successful, especially if used in conjunction with liquid seaweed, such as Natrakelp™. Our observations conclude that to optimise successful growth characteristics, such liquid fertilizers should be applied every 4 weeks at a rate of 5 ml/m^2 in

conjunction with 10 ml/m^2 formula of N:P:K: being in a ratio of 10:10:29 every month during the plant's growing season.

Properties of Grassed Superstrate

The turf of the present invention may be adapted to display mechanical and agronomic properties adapted to a range of applications.

Mechanical properties may include resilience, impact resistance, hydraulic conductivity and retention, traction and surface evenness.

Mechanical properties are functions of variables in the production process including, elastomer granule size, thickness of the superstrate, rate of extrusion and degree, if any, of compressive rolling of the extruded material prior to curing.

It is a particular feature of the present invention that these properties may be controlled to within close tolerances, thereby allowing the superstrate to meet the specific surface characteristics of the application for which it is intended.

Agronomic properties are functions of the species of grass selected and its ongoing maintenance including mowing, watering and the application of such additional nutrients as might be required from time to time. Particular grasses are preferred for various sports, for example to confer specified playing conditions such as rolling and bouncing characteristics of balls and for

resistance to mechanical damage, for example from football boot studs and other sporting equipment.

Examples of test results of comparisons of various superstrate and grass combinations with established turf structures adapted to football playing fields are shown at Figs. 3 to 5. Fig. 6 is a summary of comparison tests between a 75-80mm turf according to the invention with a natural grass at two playing field locations.

The nature of the superstrate is such as to inhibit infestation of burrowing beetles (as well as soil inhabiting fungi and bacteria).

Examples of Applications

Applications of the turf of the present invention may be conveniently divided into the categories of non-porous and porous surface applications.

Non-porous applications will include the application of the turf to roofs of buildings, terraces and other hard surfaced areas. Such areas may be serviced by the application of the turf in strip or modular form, that is, in squares or rectangular sections extruded onto tray structures.

Because the superstrates of the present invention possess excellent hydraulic conductivity, the application of the superstrate on these surfaces does not present any drainage difficulties as water percolates readily to the supporting surface and thence horizontally to follow the

inherent drainage pattern of the surface to any pre-existing exit drainage point.

The structural integrity of the turf allows it to be positioned at virtually any angle to the horizontal, thus allowing its application, for example, to steeply sloping roof surfaces and even as decorative paneling.

Applications of the turf to porous surfaces will include most sporting applications. The selection of any one of the forms of the turf will depend on the area to be covered and the mechanical and agronomic properties required but may also be influenced by specific needs for servicing of areas of extreme wear. Thus for example the application of the turf to a large area such as a football field may use a combination of all three forms. Goal mouth areas may be surfaced with interchangeable tiles or tray modules and side lines may be provided from rolled strips. Again advertising indicia areas may be serviced by specially prepared modules, allowing rapid exchange of advertising sponsors as required.

Modules may be grassed and kept in storage under suitable conditions so as to be available as replacements in areas of high wear or as advertising indicia requires changing.

As for conventional grassed surfaces in large sporting arenas, undersurface drainage is crucial to maintaining playability and grass condition. A major advantage of the

turf of the present invention is the excellent water permeability of the superstrate such that saturation of the surface and pooling of water is virtually precluded given a properly installed subsurface drainage system. Typically the turf in these applications will be laid on a sand or other porous aggregate base which is provided with an embedded grid of drainage elements as shown schematically in Fig. 11. Because of the efficient water passage through the superstrate there is the potential for excellent water recovery and storage for subsequent recycling as more fully described below.

Drainage performance is further aided by the typically much reduced depth of profile of the playing surface over the drainage structure offered by the present invention. Typical playing field profiles of sand and soil may have depths of 300mm or more leading to a greater likelyhood of water saturation and water logging. By contrast required mechanical properties for such football or cricket ovals for example may be achieved with turf of the present invention of around 100mm as may be seen from the test results shown in Figs. 3 to 5.

Surfaces for such venues as football, hockey, baseball and other running and physical contact sports require a high degree of resilience to protect players from injury. The superstrate of the present invention provides excellent

resilience characteristics in thicknesses typically in the range of 90 to 120mm.

A further major advantage of the superstrate of the present invention lies in the relatively small changes in the mechanical property of resilience between dry/moist and wet/saturated states. As may be seen for example from Fig. 7 the football rebound resilience remains within the standards required.

Similar superstrate thicknesses are appropriate to the running tracks of horse race courses. In this application also the properties of resilience, excellent drainage and hard wearing are of paramount importance.

Where impact contact is of minor or no importance, quite thin turf may be laid on porous surfaces as long as that surface will accept penetration of at least a portion of the root structure of the grass. Such thin layers in the range of 20 to 35mm are sufficiently flexible to be moulded to undulating and even sharply curved surfaces, such as for example around golf course tees and bunkers.

This property of conformation to curved surfaces also allows the application of the turf for surface rehabilitation or stabilisation such as for example in erosion channels and steep embankments.

Yet a further application of the turf may be found in stabilising contaminated soil where the superstrate may be

used as a sealing layer, preventing wind born and water born dislodgment of pollutants.

Methods of Use

The selection of the method of application of the turf to a particular surface and for a particular application will involve an evaluation of the economic advantages of any one method over another. The production of superstrate in situ by means of road surface laying machinery will be cost effective for large areas but reducingly so for smaller areas where the cost of transport of the machinery and other on-costs begin to predominate.

The selection of the process of laying in situ even for relatively large areas may be complicated by the need to incorporate modular interchangeability for areas of high wear or advertising indicia.

Example 1

Fig. 8 and 9 illustrates a playing arena 30 having applied to a portion of a surface 31 thereof a plurality of modules 23 layed in contiguous array 34.

Each module 23 comprises a portion of turf 10 which has been manufactured in accordance with one or more of the processes described in the examples above.

In this instance each module 23 comprises a portion of turf 10 supported by a tray structure 23 as illustrated in the detail in Fig. 2C.

In a particular preferred form the tray structure 23 includes at least one lifting point 24 extending upwardly from the center of tray structure 22 or disposed at the four corners 25.

Lifting points 24 or 25 are adapted to provide mechanical purchase for extraction tools (not shown) and lifting device 32, in this example mounted on transport vehicle 33, by which means modules may be placed in position or by which any module can be lifted clear of adjacent modules in array 34 for the purpose, for example, of replacement by an alternative or substitute module 23.

Example 2

Figure 10 shows a further example of a playing field 40 for football where a number of areas are subjected to differing degrees of wear and use. Thus the main playing area 42 may preferably form one continuous permanent surface but areas 42 and 43 adjacent to goal mouths 44 and 45 and strips along the side lines 46 and 47 are best served by utilizing interchangeable modules 23 and strips 48.

Furthermore one or more selected areas 49 at strategic locations in playing field 40 are required for the display of advertising indicia which require regular exchange.

In this application of the invention, main area 41 may be laid in situ in large continuous strips 50 by the road surfacing machinery as shown in Fig. 2A. The areas to be

made replaceable are excluded from this process, either by suitable formwork or later excision of the unwanted sections.

Goal mouth areas 42 and 43 are then laid with modules 23 while the side lines 46, 47 may be surfaced from rolled strips 48, both modules and strips manufactured off-site. Similarly, advertising areas 49 are formed from modules prepared off-site.

The water permeability properties of the turf of the present invention virtually eliminates surface water remaining exposed to evaporation. Thus with an efficient subsurface water drainage and collection system substantially any water applied to the surface and not taken up for the purposes of grass growth may be recovered. This provides opportunities for significant water saving; a particularly significant factor in sporting fields in arid areas.

With reference to fig. 11 a playing field 60 has turf 61 applied to subsurface 62. Subsurface 62 is provided with interconnected drainage elements 63 directing water 64 permeating superstrate 65 into collection tank 66. As required, water 64 is drawn from collection tank 66 by means of pump 67 for distribution via spraying system 68 to turf surface 61.

Methods of Commercialization

The turf of the present invention may be made available to a user in a variety of ways. Thus for example a given area of surface to be grassed for a particular application may be assessed as suitable to any one of the methods of application described above. Where the whole of the surface to be grassed may be economically covered by direct application of the superstrate in strips. Continuous in situ manufacture is economically viable for level areas larger than a certain minimum. Above this minimum, the superstrate may be supplied on a sliding cost scale where the cost per unit area decreases with the increase in the area to be covered.

Below this minimum area, cover has to be supplied from superstrate stock manufacture off-site.

Where for example a surface is a sport playing area where some specified areas are identified as high wear indicating the use of turf tray or turf strip application the cost structure will include the varying costs of providing the mix of turf application methods then required. To this may be added specific requirements for advertising indicia supply and exchange.

In both the above examples, additional costs may be associated with subsurface and drainage preparation and any added contractual arrangements for surface maintenance and repair.

For areas of relatively light use, the application of relatively thin, rolled strips of superstrate is appropriate and especially so for sloping and broken terrain. In these applications costs may largely be confined to costs of manufacture, transport and laying.

The above describes only some embodiments of the present invention and modifications, obvious to those skilled in the art, can be made thereto without departing from the scope and spirit of the present invention.